

pMSSM benchmarks for SUSY

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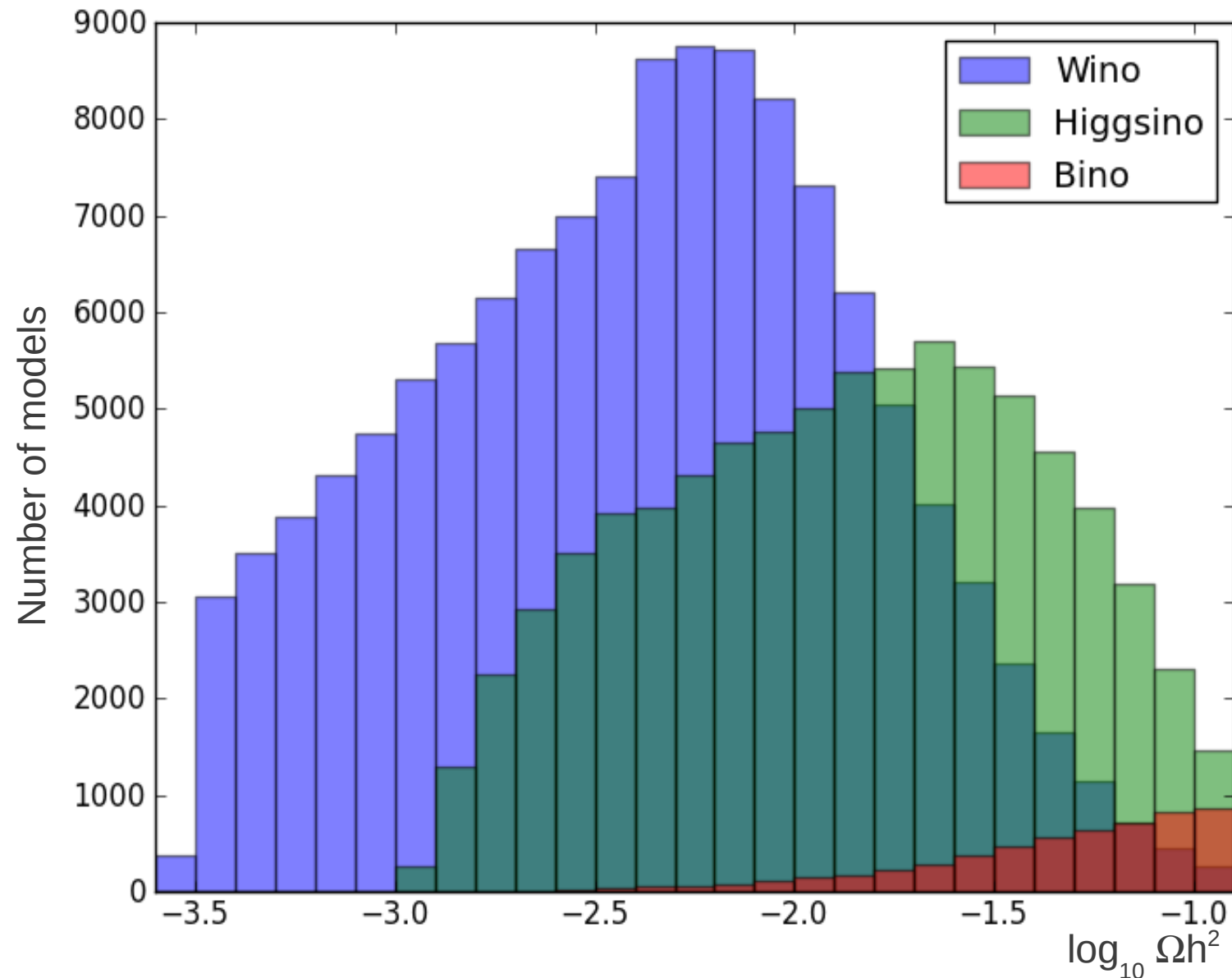
Matthew Cahill-Rowley, JoAnne Hewett,
AI, Michael Peskin, Tom Rizzo

<http://www.slac.stanford.edu/~aismail/snowmass>

The phenomenological MSSM

- Start with the MSSM with R-parity
- Take minimal flavor violation, CP, diagonal sfermion masses with first two generations degenerate; motivated by experiment!
- Scan the resulting 19/20-dimensional space, up to 4 TeV sparticles, searching for points consistent with all existing constraints: [precision electroweak, flavor, colliders \(1206.4321\)](#)
- Choose models where [lightest neutralino/gravitino is LSP](#), but do **not** require LSP to saturate relic density; 2.2×10^5 models with each LSP type before Higgs discovery, LHC through 09/2012 [\(1211.1981\)](#)

Neutralino LSP relic density

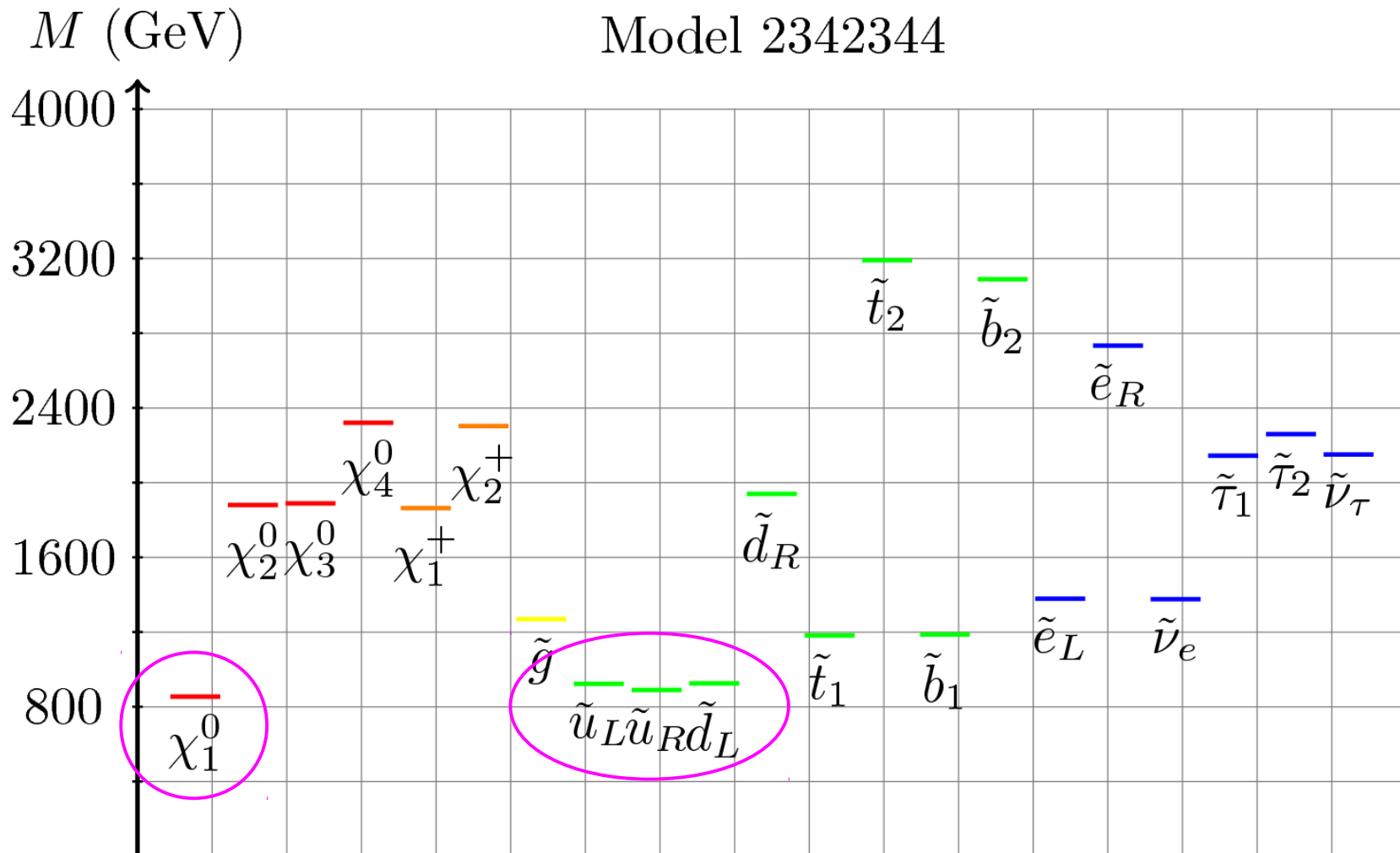


Winos and higgsinos annihilate more (mixtures not shown)

What happens if the LSP makes up all the dark matter?

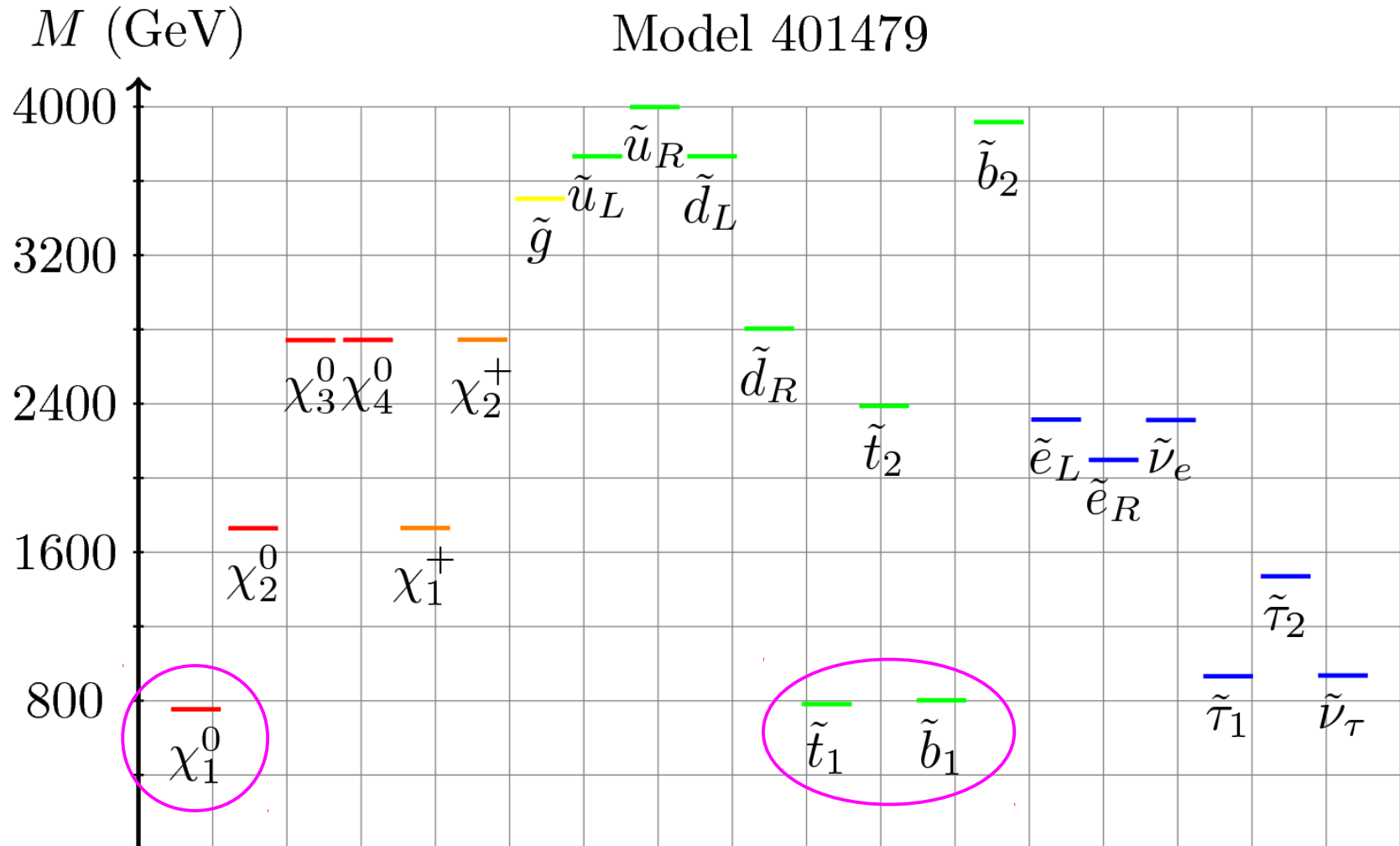
- Goal: get small set of neutralino LSP benchmarks with right m_h and relic density
- Require $m_h = 126 \pm 1$ GeV, neutralino LSP relic density within 1σ of WMAP, check against LHC constraints
- 24 models, representing many collider and DM scenarios; all are **online**!
- All standard DM mechanisms represented; compressed spectra common
- Select several showing **breadth** of MSSM DM

Bino-squark coannihilation



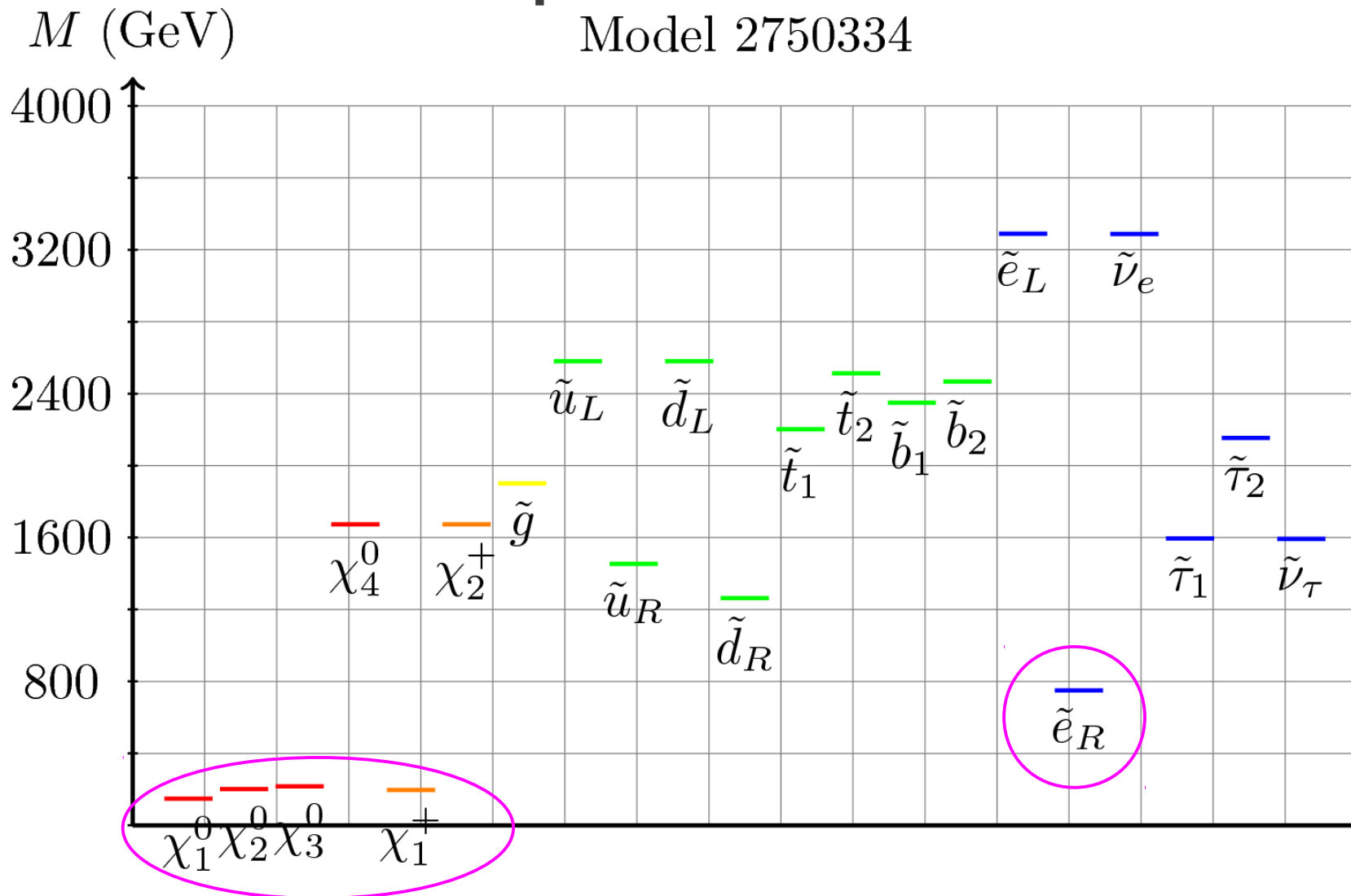
Compressed spectrum makes squarks difficult to see

Bino-stop coannihilation



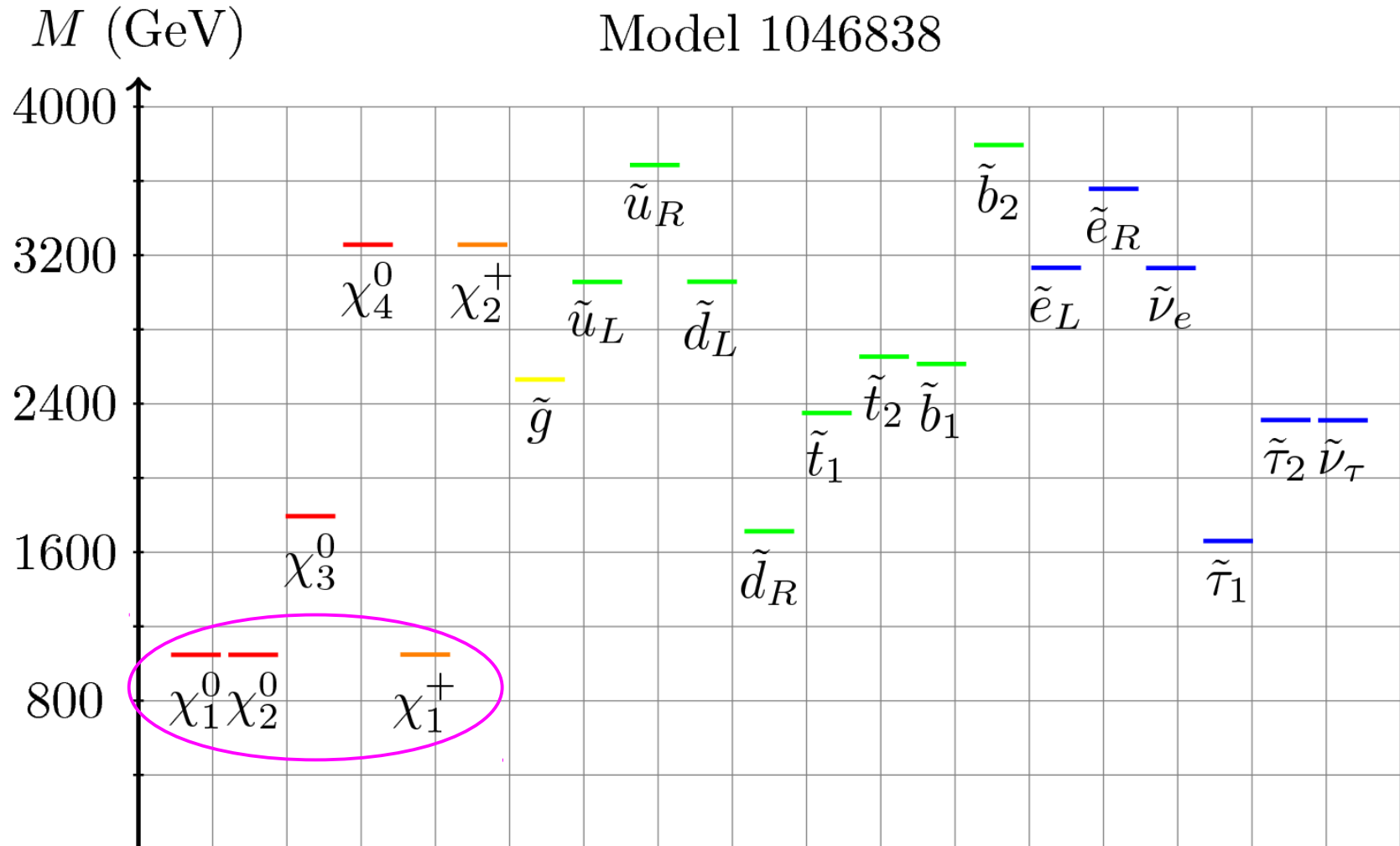
Now, 1st/2nd generation squarks are decoupled
 Very challenging to see stops and sbottoms

Well-tempered neutralino



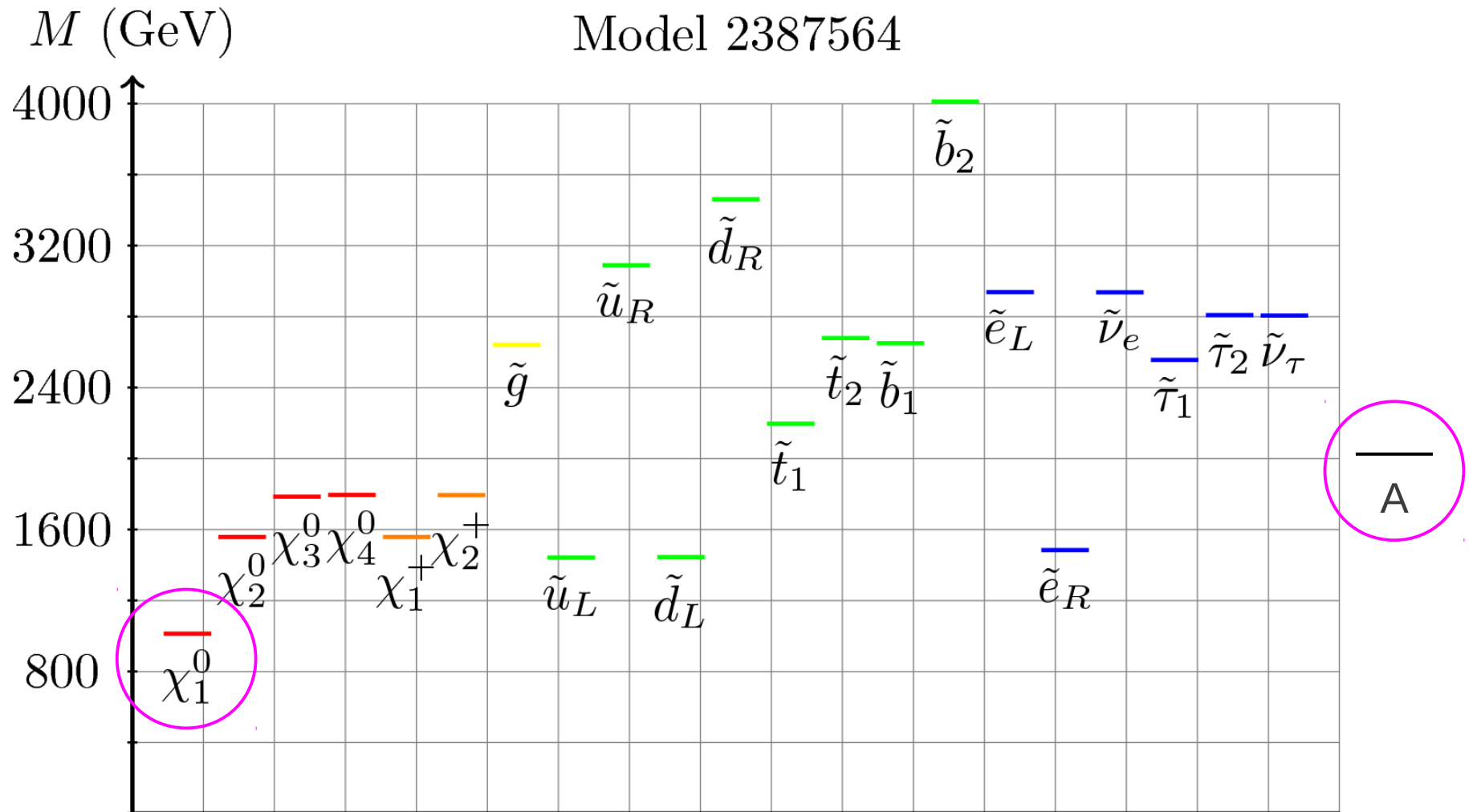
All states below 1 TeV are uncolored
Consider studying with linear collider

“Goldilocks” Higgsino



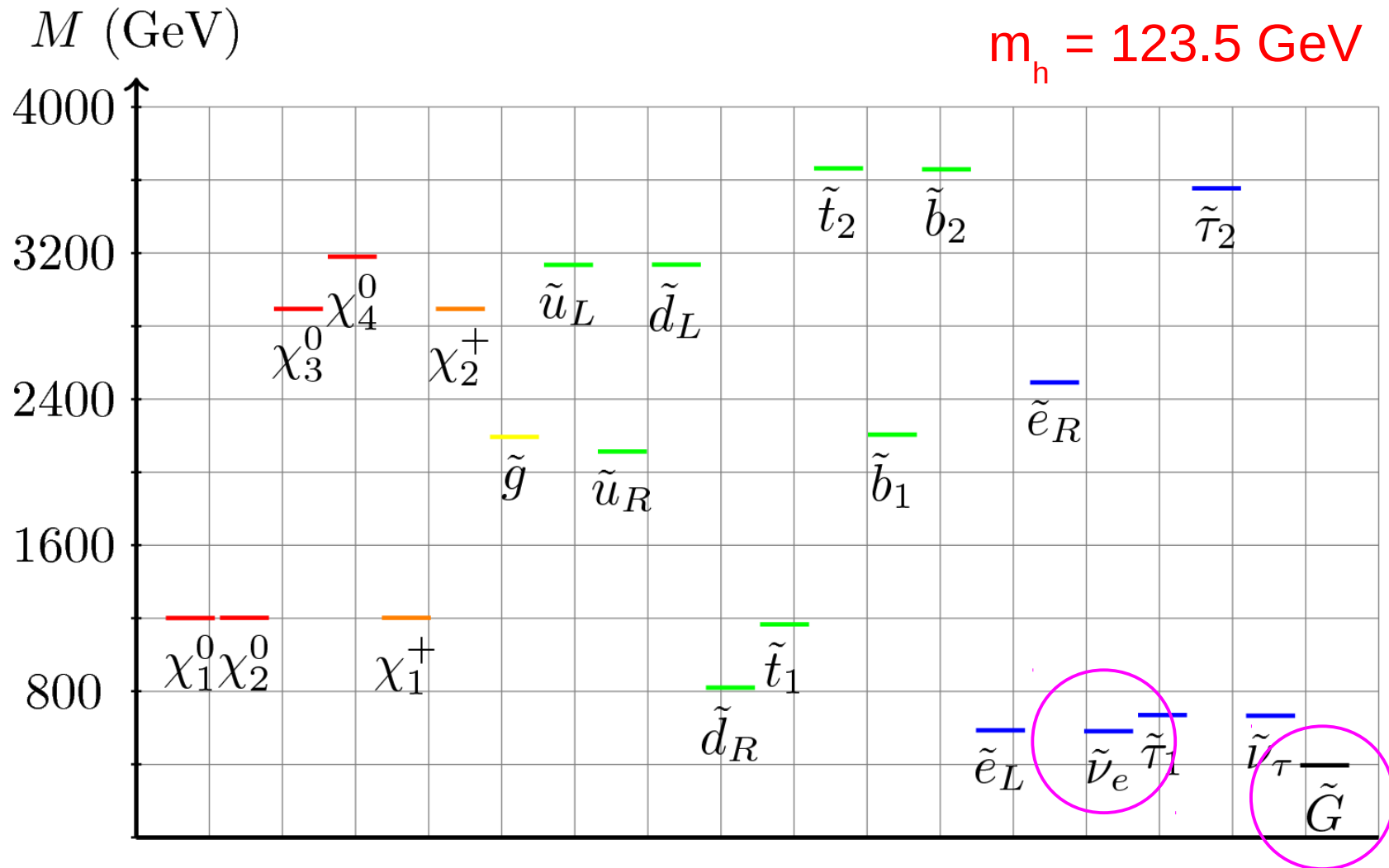
Higgsino at 1 TeV gives right relic density
 Heavier Higgsino LSPs typically require coannihilations

A funnel



Bino at 1013 GeV, A at 2043 GeV \rightarrow resonant annihilation

Super-WIMP from gravitino LSP set



Only **non-thermal** production of DM considered, from decay of detector-stable sneutrino NLSP; correct relic density
 Lots of **leptons** in final states

pMSSM Snowmass spokes

- Can define lines in pMSSM parameter space that pass through benchmark models, retaining the right relic density and Higgs mass
- These lines are generally **finite in length!**
- Example: for bino-squark coannihilation, raise bino/squark masses while reducing their splitting; eventually, **direct detection** becomes constraining
- **Multiple** potential spokes for each benchmark

www.slac.stanford.edu/~aismail/snowmass

pMSSM Benchmarks for Snowmass 2013

This page contains benchmark pMSSM points and slopes for the Snowmass 2013 study. Comments and questions should be directed to aismail AT stanford DOT edu.

[A brief introduction to these benchmarks](#)

We present several benchmark points in the phenomenological Minimal Supersymmetric Standard Model (pMSSM). We select these models as experimentally well-motivated examples of the MSSM which predict the observed Higgs mass and dark matter relic density while evading the current LHC searches. In some cases, we use a benchmark to generate a slope in parameter space by scaling the mass parameters in a manner which keeps the Higgs mass and relic density approximately constant.

After the January meeting of the BSM working group, we have introduced modified versions of many of our benchmarks, now with degenerate 1st/2nd generation squark and/or slepton masses. The original benchmarks are still available.

Bino-stop coannihilation

[SLHA file](#)
[Spectrum](#)
[Dark matter info](#)
Slopes to come!
Modified [SLHA file](#) and [spectrum](#) after January BSM group meeting

Pure Higgsino

[SLHA file](#)
[Spectrum](#)
[Dark matter info](#)
Modified [SLHA file](#) and [spectrum](#) after January BSM group meeting

Bino-squark coannihilation

[SLHA file](#)
[Spectrum](#)
[Dark matter info](#)

What's provided

- SLHA files
- Spectra
- Direct detection cross sections
- Annihilation cross sections for different channels
- Modified files after Irvine meeting; mostly cosmetic changes like making squark masses degenerate

Summary

- Have many examples of complete spectra in interesting regions of MSSM parameter space, capturing different DM mechanisms
- The benchmarks shown here can be used **across frontiers** **right now**
- Many other studies are possible with the pMSSM: Higgs properties, naturalness, complementarity of current/future collider and DM searches, etc.; we're currently working on **all** of these!